

- Floor 13 had failure of all tenant floor beams near Columns 78, 80, and 81 (Figure 11–27) and Floor 14 framing had failure of all tenant floor beams near Columns 78 and 81 (Figure 11–28). The floor beams either buckled (i.e., the east floor beam that framed into Column 80) or had connection failures (i.e., all the bolts were sheared) at the girder or spandrel beam, as a result of thermal expansion of the beams.
- At Floors 13 and 14, the girder between exterior Column 26 and interior Column 81 buckled and walked off the bearing seat due to the combined effects of (1) gravity loads, (2) lateral westward displacement due to the thermal expansion in the east floor beams prior to their failures, and (3) thermal expansion in the girder.

Axial beam stresses had increased in the south and east floor beams on Floors 12 to 14, due to restrained thermal expansion. The southeast floor slab was softened, on Floors 12 and 13, due to the local thermal expansion and crushing of concrete from the fires on those floors.

Figure 11–26, Figure 11–27, and Figure 11–28 show the connection and floor framing damage that occurred in Floor 12, 13, and 14, primarily due to the effects of thermal expansion. The east beam-to-girder fin connections had a 0.75 to 0.99 damage level between the south face (Column 26) and Column 79 at most of the floor beams. This level of connection damage also extended toward the north face (Column 44) on Floor 13, where only two connections remained undamaged. The seated connection at Column 79 had horizontal connection damage, with shear failure of all the erection bolts on Floor 13 and two to three bolts on Floors 12 and 14, respectively

Column Forces. Figure 11–29 shows the axial force in the columns at Floor 8 at 3.5 h. The axial force decreased slightly (0.04 percent) after removing some of the beams from the analysis. The change in axial forces in columns and redistribution of loads among floor columns was negligible.

Summary. The connections between the girders and interior columns were all intact, except for the girder connections between exterior Column 26 and interior Column 81 on Floors 13 and 14. At the seated connection at Column 79, all the bolts had sheared on Floor 13 and 2 to 3 bolts had sheared on Floors 12 and 14. Approximately one-half to three-quarters of the east floor beams had a connection damage level of 0.75-0.99 on Floors 11, 12, 13, and 14. The floor systems had fire-induced damage to connections, beams, and girders after 3.5 h of heating, primarily due to the effects of thermal expansion, on the north floor and east side of the core on Floor 8 and the south and east floor area of Floors 12, 13, and 14.